tionship to Pterynotus pinniger.

The finding of the apical fragment of Turcica caffea further establishes this species as a resident in the Gulf of California. I now have also four intact specimens of this species reportedly taken between Guaymas and Tastiota, 80 miles to the north. Two of these are with operculum.

An incident not related to the above trawling occurred while we were in Guaymas. Early one morning Todd Schowalter and I were looking over some of the shrimp boats that had docked during the night. On one of the boats, the nets still suspended from the rigging and still dripping water — evidence that the boat had worked off Guaymas the previous night (none of the crew was around) — I found on the deck at the bottom of the suspended nets a good (but dead) specimen of Cancellaria cooperi Gabb, 1865. Although this is only circumstantial evidence of the occurrence of this species within the Gulf of California, we must be on the alert for more specimens of this.

Considerable work needs to be done on many of the species collected, especially the turrids. When this is completed, a check list of all the species will be published along with specific data, range extensions, etc.

Fluctuations in Mollusk Populations after a Red Tide in the Estero de Punta Banda, Lower California, Mexico

by
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(Plate 4)

In an earlier issue of this journal it was reported (Stohler, 1959) that during the Red Tide of 1958 in the Estero de Punta Banda in Baja California, Mexico, a collection of mollusks was made. It was noted at that time that a great number of the individuals observed were dead, some of them relatively recently, while others had attained a more advanced state of decomposition. On a map accompanying that report (map C on Plate 6, loc. cit.) two areas were distinguished and designated I (inner portion) and O (outer portion) respectively. In that report it did not seem necessary to stress the fact that the inner portion was separated from the outer one by a relatively massive sand bar which seems to be covered by a thin layer of water only during very high tides. Nor did it seem important at that time to speculate on the possible significance of this sand bar in its effect upon the changing of the water in the inner portion. However, in the light of the present progress report it appears now desirable to consider this possible effect. It seems obvious that the inner portion would be isolated from the open ocean by the bar for a considerable portion of the time, at least during that part of the year when the high and low waters differ but little from each other. The conclusion that the inner portion would be subject to conditions which might be called "stagnant" seems inevitable. This "stagnant" condition might be assumed to cause more thorough contamination of the invertebrates living in the inner portion if such contaminating conditions do occur and somehow enter this area - as they did, in fact, enter in 1958. This conclusion seems to receive support from the observations made on June 15, 1958: death and decomposition were more pronounced in the inner portion. It was here where the Sipunculus nudus were observed as reported (Stohler, loc. cit., p. 33).

Bearing this fact in mind, it appears permissible to project that the total population in the inner portion would suffer more severely than that in the outer portion; additionally it seems logical to assume that a recovery to normal conditions would progress more rapidly in the outer portion than in the inner one.

During the month of July, 1959, it was possible for me to revisit the Estero de Punta Banda, again in company of Mr. and Mrs. Alan H. Wolfson of San Diego. Because of the importance attaching to thorough collect-

ing, two days were devoted to it, namely July 18 and 19. On the first day, both portions, the inner and the outer, were worked over. It was evident, however, that the inner portion was relatively poor and therefore the second day was spent in the outer portion only. On January 11, 1960 I had a third opportunity to collect in the Estero.

In July, 1959, the mollusk population appeared normal and healthy except that the impression was strong that none of the individuals was as large as had been observed the previous year. Moreover, it seemed that the bubble shells, Vesica gouldiana (Pilsbry, 1895) were in the midst of their breeding season. The bright orange egg strings were literally everywhere. Equally striking was the abundance of Pyramidella mexicana Dall & Bartsch, 1909. This species seemed to congregate in shallow depressions of the sand where it was possible to pick them up a dozen or more at a time.

The picture in January, 1960, however, was totally different.. Most striking was the complete absence of some of the forms that had been abundant to very common on the previous occasions. On the other hand, some species were collected that had not been met in the previous two years.

Table 1 lists all species encountered arranged strictly alphabetically. The identifications of some of these species have been verified by Drs. Leo G. Hertlein and Myra Keen, and by Mr. Allyn G. Smith, all three of whom I wish to thank for their courteous cooperation.

The table is divided into three main sections corresponding to the three calendar years during which collections were made. Each main section in turn is subdivided into I (inner section) and O (outer section). The plus sign in any column indicates that the species was collected or observed, while the negative sign indicates that the species was not seen. As any experienced field collector knows, the rarer species are not always encountered even though they are present. Thus, their absence in any of the columns is not considered significant on the basis of what other observations have been made. In this category — species observed in 1958 or 1959 but not in 1960 — belong those marked with a superior 1 preceding the name. (It seems desirable to mention here that through an unfortunate error in cutting the stencils, the name of Acteocina was garbled in the previous report; in proof reading the error was caught but the correction was overlooked; the species is, of course, Acteocina culcitella intermedia Willett, 1928, not A. californica Willett, a name which, fortunately, does not exist.)

Perhaps the only species which might not be expected in this first group is Astraea undosa (Wood, 1828). This species is encountered in great numbers only a few miles to the north in what appear to be identical conditions, namely in the Flood Control Channel in San Diego. Yet in the Estero only one single specimen was found; it was, however, a very juvenile shell, measuring but 6.1 mm. in its greatest diameter. It may be said that A. undosa is not to be considered a normal component of the mollusk population in the Estero.

More startling, perhaps, than any other single observation, might be the complete absence in 1960 of the two species marked with a superior 7, Cerithidea californica (Haldeman, 1840) and Melampus olivaceus Carpenter, 1857. Both species were very common among the sedges along the edge of the Estero in 1958 and 1959. In fact, it was reported (Stohler, loc. cit., pp. 33 and 35) that they were not affected by the Red Tide in 1958. However, the disappearance of these two species together with the fiddler crab, which was equally common before, is due entirely to human influence. Sometime between July, 1959, and January, 1960, large masses of earth and mud had been dumped on this specific area, burying the snails and crabs under several feet of material.

Six of the species encountered only once are marked with a superior 5. All were obtained in 1960, and five of them are pelecypods. In the light of a study being conducted on the variability of the species of Chione, the species Ch. cortezi (Carpenter, 1864) and Ch. fluctifraga (Sowerby, 1853) deserve special mention here. It is interesting that four different species of this genus were collected in the same ecological niche. It is even more interesting to me that it was not until 1960 that all four were obtained.

Another group of species is of interest also; it is marked with a superior 2 in table 1. This group could be subdivided justifiably

Table 1: Species of Mollusks from Estero de Punta Banda, B. C., Mexico

	1958 June 15		1959 July 18		19	1960 January 11	
	I	O	I	O	O	I	O
[1] *Acmaea conus* GRANT, 1945	−	+	−	−	−	−	−
[2] *Acmaea depicta* (HINDS, 1842)	−	+	−	+	+	−	−
[1] *Acteocina culcitella intermedia* WILLETT, 1928	+	−	−	−	−	−	−
[1] *Astraea undosa* (WOOD, 1828)	−	+	−	−	−	−	−
[1] *Balcis micans* (CARPENTER, 1863)	−	−	−	+	−	−	−
[7] *Cerithidea californica* (HALDEMAN, 1840)	+	−	+	−	−	−	−
[6] *Chione californiensis* (BRODERIP, 1835)	+	+	+	+	+	+	+
[5] *Chione cortezi* (CARPENTER, 1864)	−	−	−	−	−	+	−
[5] *Chione fluctifraga* (SOWERBY, 1853)	−	−	−	−	−	+	−
[3] *Chione undatella* (SOWERBY, 1835)	+	+	−	−	−	+	+
[2] *Conus californicus* HINDS, 1844	−	+	−	+	−	−	−
[6] *Crepidula onyx* SOWERBY, 1824	−	+	−	−	+	−	+
[4] *Crepipatella lingulata* (GOULD, 1846)	−	−	−	−	+	−	+
[1] *Cumingia californica* CONRAD, 1837	+	−	−	−	−	−	−
[6] *Donax californica* CONRAD, 1837	−	+	+	+	+	−	+
[6] *Donax gouldii* DALL, 1921	−	+	−	+	−	−	+
[1] *Epitonium cf. cooperi* STRONG, 1930	−	−	−	+	−	−	−
[1] *Eudaphnella spec.*	−	−	−	+	−	−	−
[1] *Haminoea vesicula* (GOULD, 1856)	−	+	−	−	−	−	−
[5] *Jaton festivus* (HINDS, 1844)	−	−	−	−	−	−	+
[6] *Laevicardium substriatum* (CONRAD, 1837)	−	+	+	+	+	+	−
[1] *Littorina planaxis* PHILIPPI, 1847	−	−	−	−	+	−	−
[5] *Lyonsia californica* CONRAD, 1837	−	−	−	−	−	−	+
[1] *Macoma nasuta* (CONRAD, 1837)	−	−	−	−	+	−	−
[5] *Mactra californica* CONRAD, 1837	−	−	−	−	−	−	+
[7] *Melampus olivaceus* CARPENTER, 1857	+	−	+	−	−	−	−
[6] *Mitrella cf. c. carinata* (HINDS, 1844)	−	+	−	+	+	−	+
[3] *Modiolus rectus* (CONRAD, 1837)	−	+	−	−	−	−	+
[5] *Mytilus edulis* LINNAEUS, 1758	−	−	−	−	−	−	+
[2] *Nassarius tegulus* (REEVE, 1853)	+	+	+	+	+	−	−
[6] *Olivella baetica* MARRAT, in SOWERBY, 1871	−	+	−	+	+	−	+
[6] *Olivella biplicata* (SOWERBY, 1825)	−	+	−	+	+	+	+
[2] *Pecten l. latiauratus* CONRAD, 1837	−	+	−	−	+	−	−
[6] *Polinices reclusiana* (DESHAYES, 1839)	+	+	+	+	+	+	+
[1] *Protothaca staminea* (CONRAD, 1837)	+	−	−	−	−	−	−
[2] *Pyramidella mexicana* DALL & BARTSCH, 1909	+	+	+	+	+	−	−
[1] *Tagelus californianus* (CONRAD, 1837)	+	−	−	−	−	−	−
[1] *Tellina arenica* HERTLEIN & STRONG, 1949	−	−	+	−	+	−	−
[2] *Tricolia compta* (GOULD, 1855)	−	+	−	+	+	−	−
[6] *Vesica gouldiana* (PILSBRY, 1895)	+	+	+	+	+	+	+

observed: [1]) in 1958 or 1959, but not in 1960; [2]) in 1958 and 1959; [3]) in 1958 and 1960; [4]) in 1959 and 1960; [5]) in 1960 only; [6]) in all three years; [7]) covered over by several feet of mud and earth

into two subgroups. Into the first subgroup would belong Acmaea depicta (Hinds, 1842), Pecten l. latiauratus Conrad, 1837, and Tricolia compta (Gould, 1855). These three species were found in 1958 and 1959, associated with the eel grass Phyllospadix torreyi Watson. In January, 1960, the eel grass was absent and no trace of this plant could be observed. It may be argued that the absence in 1960 of the three species of mollusks was a direct consequence of the disappearance of Phyllospadix. On the other hand, the second subgroup consisting of Conus californicus Hinds, Nassarius tegulus (Reeve, 1853), and Pyramidella mexicana Dall & Bartsch, 1909, not being dependent upon this "host" plant, could not be assumed to have been affected in the same way and yet these three species also were not observed in 1960.

In Table 2 are given figures obtained by measuring the different lots of Pyramidella mexicana collected. The impression previously mentioned, that the specimens in 1959 were not as large as those observed the year before is confirmed by the actual measurement of every specimen collected. The table also shows that the Pyramidella population in the outer portion had a more normal appearance in 1959 as to numbers of individuals. The comparison of the two sets of figures, however, makes the total disappearance of this species even more striking. If the samples of both areas are pooled for the respective years, the following mean sizes are obtained: in 1958: 16.3 mm.
in 1959: 13.3 mm.
This difference of almost 20% is even more surprising if one considers that the collecting date was one month later in the year in 1959 than in 1958; this fact might lead one to assume that on the basis of an annual cycle the population would be older in July than it is in June and therefore the average size of the shells should be larger in the later month. No logical explanation for the reversed condition comes to mind and this must remain, for the time being, another riddle to be solved in the future.

Yet, at the same time, the decrease in size cannot be attributed, I believe, to an after-effect of the Red Tide nor could it have been interpreted as foreshadowing the complete disappearance of the species.

Breeding cycles cannot be adduced, I believe, for an explanation either, since very small individuals were obtained in 1959. This fact can only be interpreted, it seems, to mean that the generations overlap at least to some extent, if it does not indicate that the individuals live for more than one whole year. Of course, we encounter a great handicap here, since we know very little about life spans of mollusks in general.

Only two species were found in 1958 and in 1960, but not encountered in 1959. These two, Chione undatella (Sowerby, 1835) and Modiolus rectus (Conrad, 1837), are marked with a superior 3. At the present status of this continuing study nothing more can be said about these forms than to note the fact. The same applies to the single species, Crepipatella lingulata (Gould, 1846), found in 1959 and 1960; it is marked with a superior 4 in our table.

Table 2: *Pyramidella mexicana*
(Measurements in millimeters)

			greatest height	mean height	greatest diameter	number of individuals
I	1958	la	19.3	17.1	6.4	23
		sm	9.0		3.7	
	1959	la	20.5	14.4	6.7	44
		sm	9.8		4.5	
	1960	la	—	—	—	—
		sm	—		—	
O	1958	la	21.3	16.0	7.5	53
		sm	9.8		3.6	
	1959	la	21.9	13.2	7.1	358
		sm	5.9		2.8	
	1960	la	—	—	—	—
		sm	—		—	

The last group of species includes the dominant forms, which were obtained on each of the three occasions. They are marked in the table with a superior 6. While we will single out two species of this group for a more detailed scrutiny, it is understood that fundamentally the same facts apply to the other eight species so designated.

Chione californiensis (Broderip, 1835)

Chione, to be considered first, is easily collected, even when it is healthy. For this reason it seems to be a favored item for the food collectors. In spite of the ease of collecting, only relatively small numbers were

Figure 1

Figure 2

Figure 3

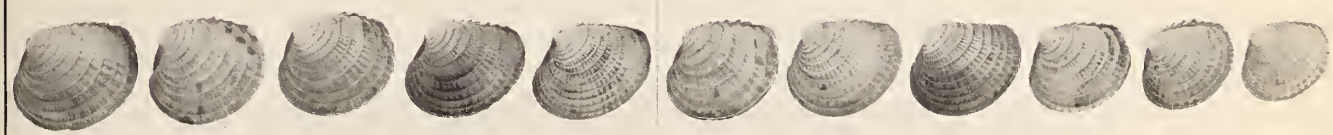

Figure 4

Figure 5

Figure 6

Figure 7

All Figures Natural Size - See Text for Explanation